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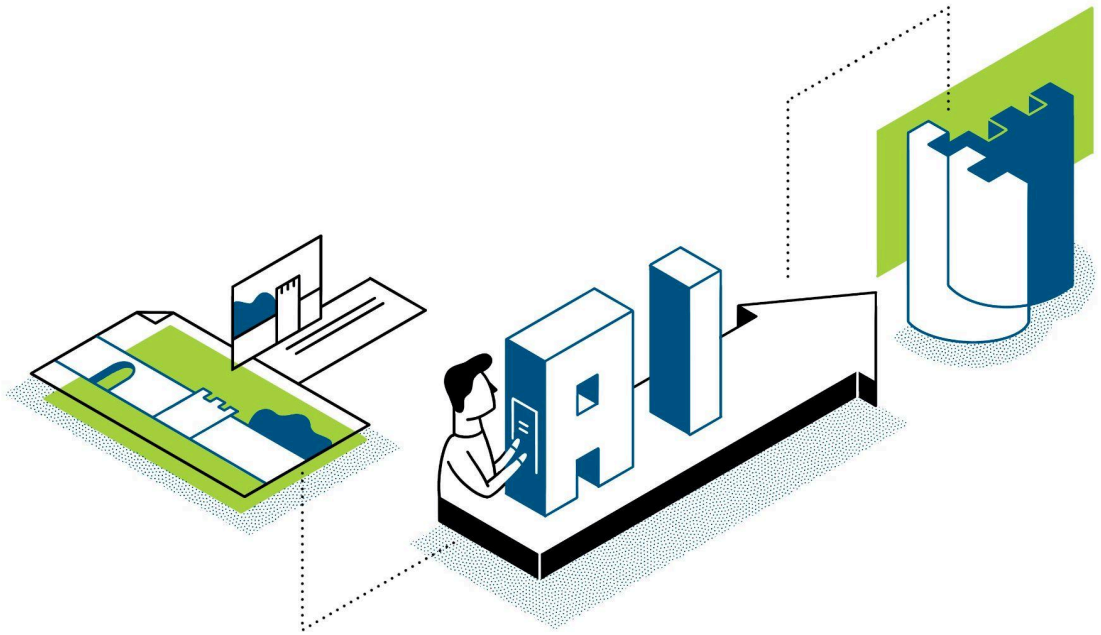

AI 3D Builder

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INTRODUCTION

This step-by-step guideline introduces the AI 3D Builder, a workflow designed to help users generate 3D models from images using AI-based tools and refine them for use in XR, web, or research environments.

The guide focuses on accessible, practical steps, allowing Cultural Heritage professionals and content creators to transform 2D images into usable 3D assets without requiring advanced technical expertise.

By following this guide, you will be able to:

- Prepare images for AI-based 3D generation
- Generate a 3D model using an AI tool
- Clean and optimise the model in Blender
- Create and apply textures
- Export a final model ready for visualisation

THIS GUIDE IS INTENDED FOR

- Cultural Heritage professionals
- Archivists and researchers
- XR and creative professionals
- Anyone interested in AI-based 3D modelling

No programming skills are required. Basic familiarity with images and files is sufficient.

TOOLS AND SOFTWARE USED IN THIS GUIDE

For both 2D images and 3D models editing, any possible software can be used but this guideline will show the use of respectively Photopea and Blender for them, both accessible for free.

- Photopea (web-based) for image preparation and editing
  - Download link: https://www.photopea.com/?utm_source=homescreen
- Trellis (web-based AI tool) for generating 3D models from images
  - Download link: https://huggingface.co/spaces/Trellis-community/Trellis
- Blender (desktop application) for cleaning, editing, and exporting models
  - https://download.blender.org/release/Blender4.2/blender-4.2.2-windows-x64.msi

BEFORE YOU START, YOU WILL NEED

- A computer (Windows, macOS, or Linux)
- Internet access
- Basic image files of the object you want to model
- Optional materials
  - Multiple images of the object (recommended for better results)
  - High-resolution photos

Preparation of your materials and workspace

- Organise your project into folders:
  - Input images (original and cleaned)
  - AI-generated models
  - Blender project files
  - Final exported models
- Ensure that:
  - Images clearly show the object of interest
  - Background elements are minimised or removable
  - The object is visible from different angles (if possible)

Overview of the workflow

The AI 3D Builder workflow consists of four main stages:

1. Image preparation in Photopea: isolate and clean the object in images
2. 3D model generation in Trellis: use AI to create the model
3. Model correction in Blender: refine geometry and fix errors
4. Texture preparation in Photopea
5. Texturing and export in Blender: apply textures and prepare final output

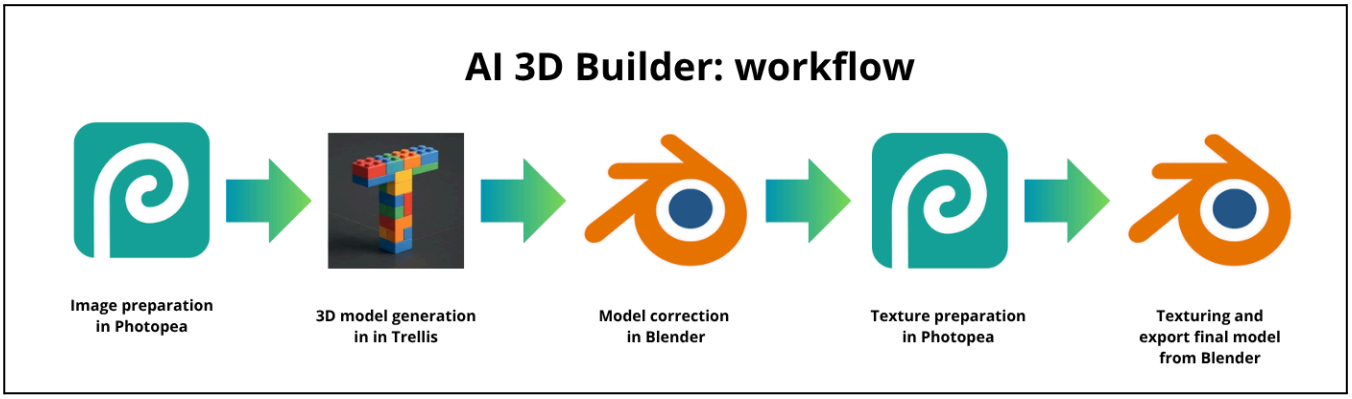


Figure 1 Overview of the workflow

STEP-BY-STEP GUIDELINES

STEP 1: IMAGE PREPARATION (PHOTOPEA)

The images to be provided as input to the AI Tool (Trellis) for modeling must first be specifically prepared. Therefore, it is necessary to ensure that the AI Tool focuses its attention exclusively on the object we wish to reproduce, leaving out anything superfluous or likely to generate errors (trees, vegetation, street furniture, etc.).

The background must be removed, leaving only the object of interest. The tool is able to perform this procedure automatically; however, the background removal algorithm is not so effective in the case of images with many details or with excessively uniform colors. It's important to remove as many unwanted elements as possible to obtain a final product that requires minimal manipulation. If this isn't possible, you should still try to correctly cut out the object of interest, so as to provide the AI tool with its general shape.

WHAT IS PHOTOPEA?

Photopea is a free, browser-based image editing tool used to prepare images before processing them with AI tools.

📺 **WATCH THE DEMO VIA THIS LINK:** [IMAGE PREPARATION (PHOTOPEA)]

HOW TO PREPARE YOUR IMAGES?

1. **Open Photopea**
2. **Upload your image** (File → Open)

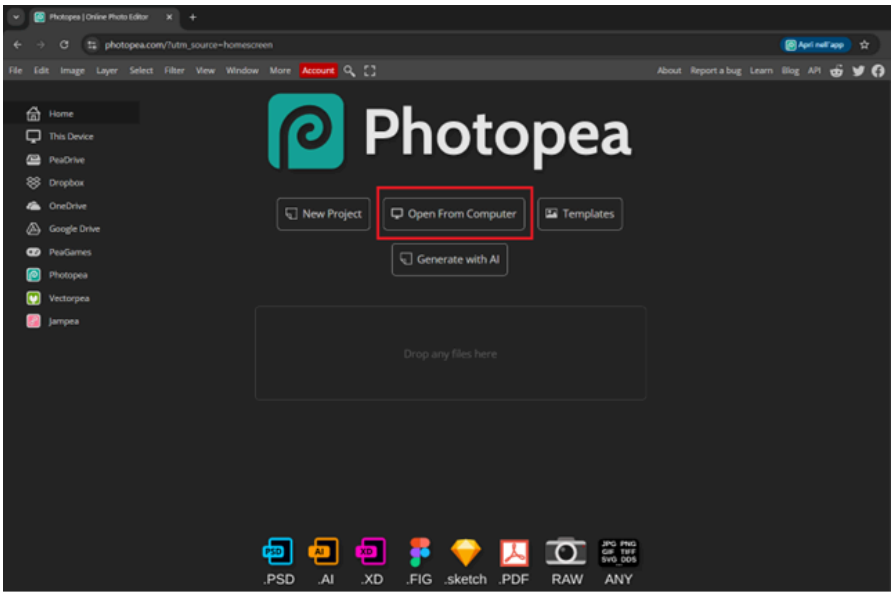


Figure 2 Uploads in Photopea

3. **Remove the background:**
    a. Use the Lasso tool
        i. The default option is Lasso Select. To be able to select the object, **the option Polygonal Lasso is recommended**; this option can be accessed by long-pressing the Lasso tool and selecting Polygonal Lasso Select.

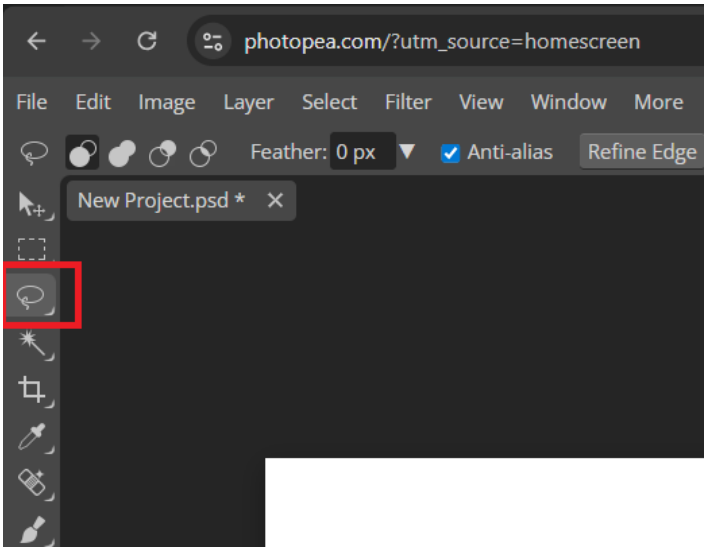


Figure 3 Lasso tool

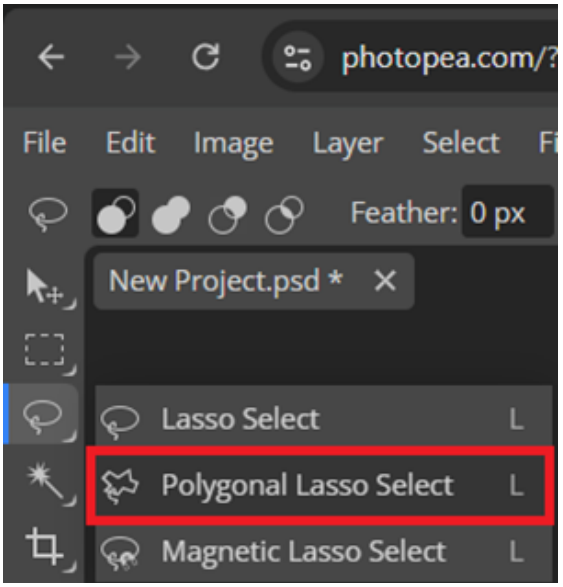


Figure 4 Polygonal Lasso Select

    b. Once the object's shape is defined, invert the selection: go to **Select → Inverse**
        i. The selection will now include all the objects to be deleted, except the object we're interested in.

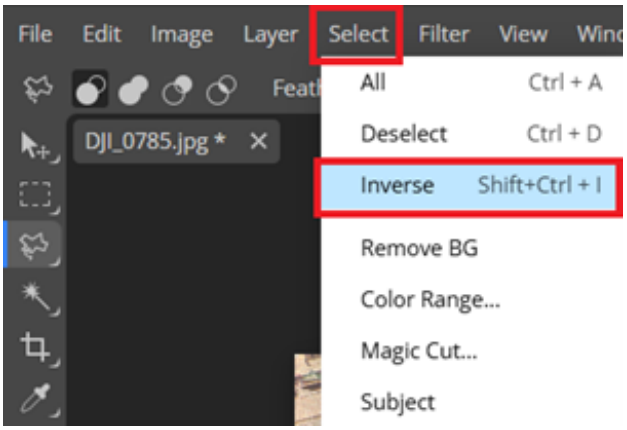


Figure 5 Inverse in Photopea

    c. To remove the unwanted items, **press the DELETE button** on your keyboard.

4. **Export the image:**
    a. **File → Export As … → PNG**

The resulting images must be saved in .PNG format to preserve the transparency of the removed image portions. Saving in .JPG format automatically fills the deleted portions with white, which could cause calculation errors in the AI Tool.

Important: Clean images significantly improve AI-generated results by reducing unwanted artefacts.

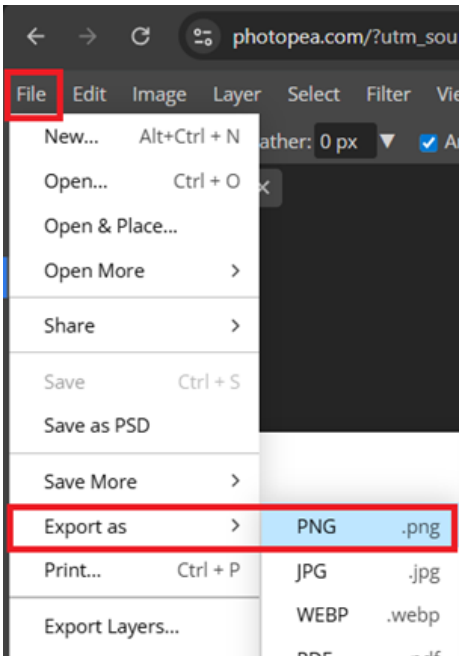


Figure 6 Export path in Photopea

STEP 2: 3D MODEL GENERATION (TRELLIS)

WHAT IS TRELLIS?

Trellis is **an AI-based web application that generates 3D models from one or more input images**. To use the 3D model generation tool, go to https://huggingface.co/spaces/Trellis-community/Trellis. The web app interface will open.

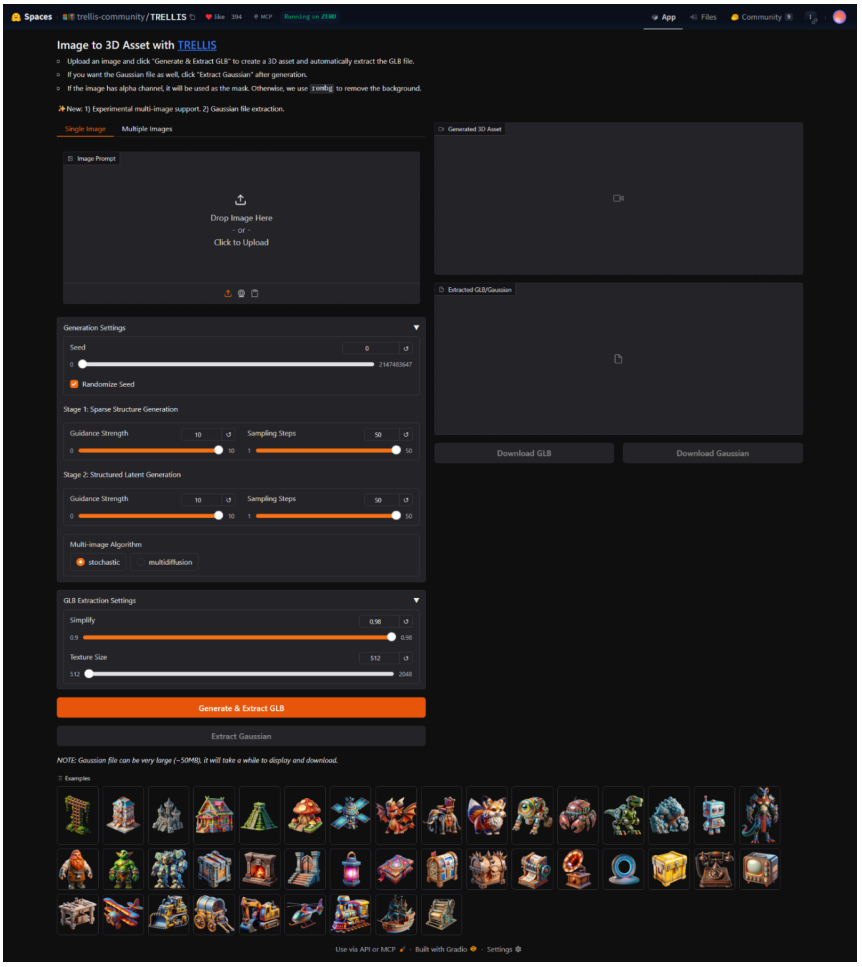


Figure 7 Trellis web interface

WATCH THE DEMO VIA THIS LINK: 3D MODEL GENERATION (TRELLIS)

Uploading your image(s) and configuration

1. **Open Trellis** in your browser.

2. **Upload one or multiple images** that need to be computed for 3D model creation.
   - Do this in the left upper section 'Image prompt' of the interface. (figure 7)
   - You can drag and drop images, or by uploading them from your computer.
   - If you opt to compute multiple images, select the **Multiple images tab.** Keep in mind that this is an experimental feature and may not always provide the expected results.

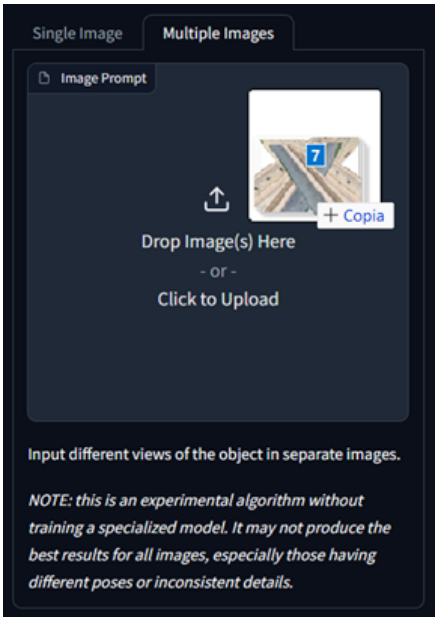


Figure 8 Trellis upload screen

3. **Configure Generation settings**:
   - Do this in the middle section on the left. (figure 7)

GENERATION SETTINGS

- **Seed:** The "seed" value establishes a random configuration for the 3D model generation.

For the other parameters it is better to **stick to the following values,** so the model can be generated following the input images as faithfully as possible. The general guideline is that the higher the value set for each parameter, the less room for free interpretation by the A there will beI.

- **Stage 1: Sparse Structure Generation**
  - Guidance Strength: 10
  - Sampling Steps: 50
- **Stage 2: Structured Latent Generation**
  - Guidance Strength: 10
  - Sampling Steps: 50
- **Multi-image Algorithm:** Stochastic

4. **Configure GLB Extraction settings**
    - Do this in the bottom section on the left. (figure 7)
    - These settings allow you to set the parameters for saving the 3D model, with the option to save it in .GLB or Gaussian (.PLY) format. **The Gaussian PLY (Polygon File Format)** is a technology that uses points instead of traditional polygons to represent 3D models. It enables a lighter, more detailed, and dynamic representation of materials, textures, and reflections.

GLB EXTRACTION SETTINGS

- **Simplify: 0.98**
- **Texture Size: 512**

Important: Depending on the degree of fidelity desired compared to the input images, the parameters are set accordingly: if the goal is to obtain a model that adheres as closely as possible to the input images, the parameters should be set to the maximum; conversely, if the AI Tool is preferred to have greater freedom of interpretation, the parameters can be set to intermediate values or to the minimum.

3D Model creation and export

1. Click **Generate & Extract GLB** to start the model creation process. Wait for the mesh to calculate.
2. **The model is displayed** in the Generated 3D Asset section (as a panoramic video; upper right section, see figure 7) and in the Extracted GLB/Gaussian section (as a real-time view; lower right section, see figure 7).
3. **Click Download GLB** to export the resulting model.

Tip: Using multiple images improves accuracy but may produce inconsistent results depending on quality.

Step 3: Fixing the 3D model (Blender)

The model calculated by the AI Tool, in most cases, never turns out as expected: there are always imperfections resulting from an erroneous interpretation by the AI or objects that could not be eliminated during the cleaning phase of the images supplied as input to the Tool. It is therefore necessary to manipulate the generated object in order to eliminate everything that is not necessary and leave only the desired object. However, often eliminating these artifacts creates gaps that must be rebuilt from scratch, creating vertices, edges, and faces.

To fix the object, the 3D object manipulation software Blender is used.

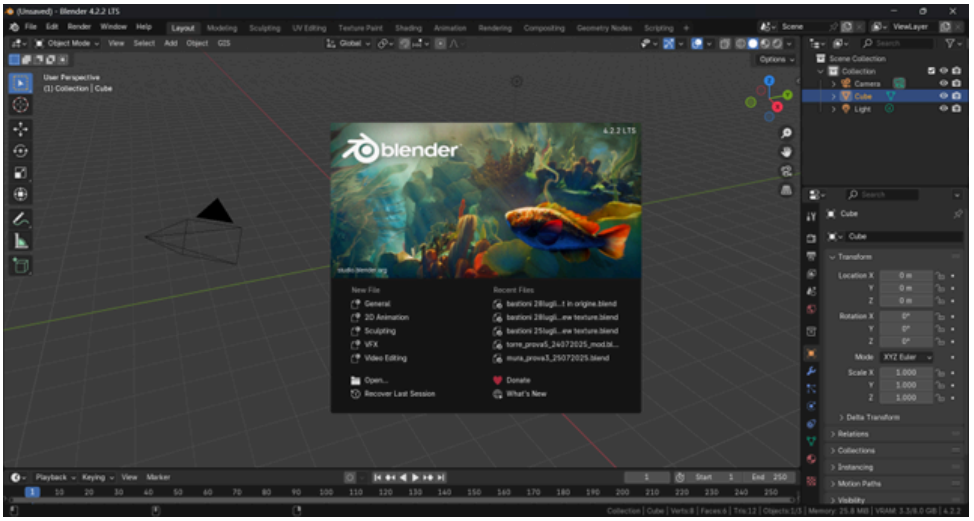


Figure 9 Blender web interface

What is Blender?

Blender is a free, open-source 3D software used for editing, cleaning, and optimising 3D models.

> Watch the demo via this link: FIXING 3D MODELS (BLENDER)

Basic commands in blender

Once installed, the software welcomes the user with an introductory screen that allows them to select the interface language, choose a tool preset, view recently opened files, and open the file browser to select an existing file.

Key	Function
Left Mouse Button (LMB)	Select an object in the scene
SHIFT and LMB	Select multiple objects
LMB and drawing a window from left to right	Select all the objects inside the selection window
Right Mouse Button (RMB)	Open the context menu
Middle Mouse Button (MMB)	Orbit View
SHIFT and MMB	Pan View
CTRL and MMB	Zoom View

Mouse Wheel	Zoom View In or Out
X	Delete the selected item with a confirmation dialog.
Del or Canc or Delete	Delete the selected item without a confirmation dialog.
M	Merge objects/vertices/edges/faces
TAB	Switch Object/Edit Mode
G	Grab the selected object

How to import the 3D model?

1. **Delete any preexisting models** in Blender before import.
    a. Select the existing objects while holding down SHIFT, or by clicking on the models or selecting them by dragging.
    b. Press DELETE on your keyboard.
    c. You are left with an empty scene with the Cartesian X (red) and Y (green) axes.

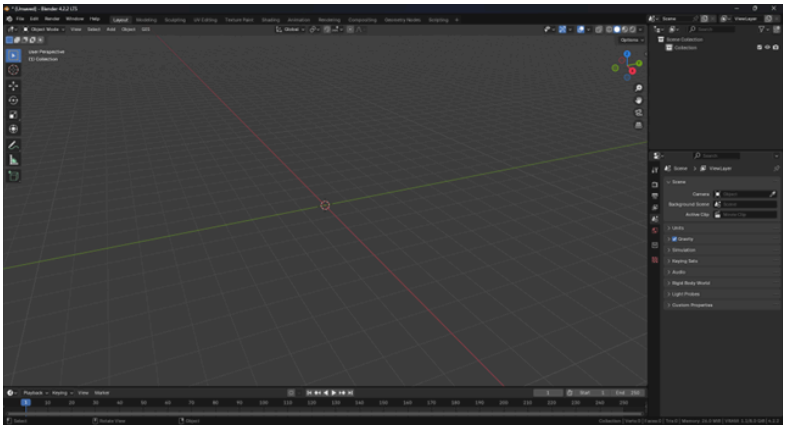


Figure 10 Empty scene in Blender

To import a model

1. **Click File → Import → select file type**
    a. Models from Trellis have a .GLB extension. **Choose glTF 2.0 (.glb/.gltf)**.
2. **Select** your generated model and **click** Import glTF 2.0.

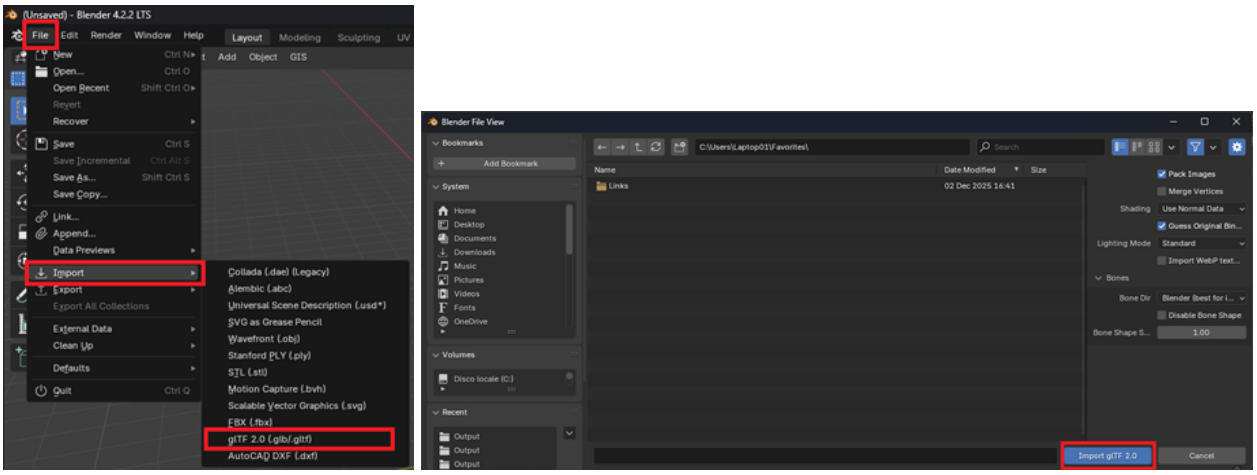


Figure 11 Import path in Blender

How to clean the mesh?

Remove unwanted geometry

1. **Select** the object.

2. Enter **Edit Mode** (press TAB on keyboard).
    a. In Edit Mode, to the right, there are 3 buttons: **the selection filter** with **Vertices, Edges and Faces respectively.**

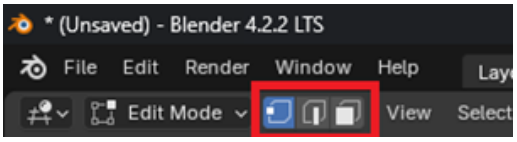


Figure 12 Filters in edit mode in Blender

    b. These allow you to manipulate, create, and delete vertices, edges, and faces.
3. Select the **filter 'vertices'.**
4. **Select the vertices in the 3D model that need to be deleted.**
    a. Hold down the **SHIFT** key on the keyboard for multiple selections.
5. Press the **DELETE** key on the keyboard.
    a. This will leave gaps that will be filled in during the next step. Figure 13 below is an example of error deletion.

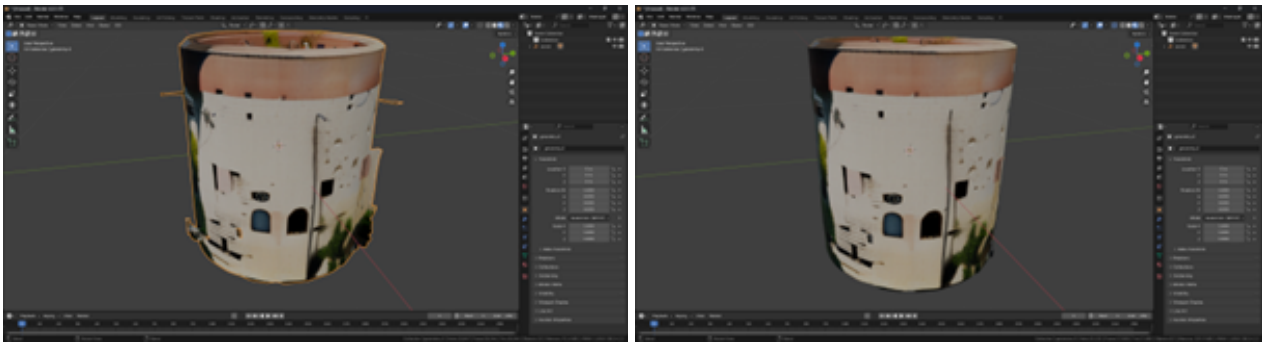
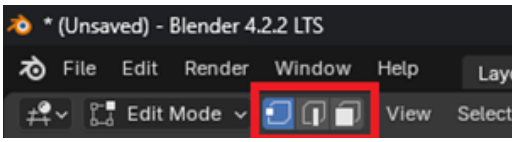


Figure 13 Example of error deletion

Close gaps

When eliminating errors resulting from the 3D generation process, it often happens that some of the eliminated faces belong to the surface of the object in question. **Removing the faces leaves gaps that can be restored without affecting the overall shape of the object.**

1. Select the 3D model
2. Enter **Edit mode**
3. Select **Vertices filter**



4. Select the three vertices of the gap
5. **Press F** on your keyboard to create a polygon
6. Repeat for the other gaps

Tip: When two or more vertices are too close to each other, you can merge them by pressing the M key on the keyboard. Pressing M opens a context menu that allows you to determine how the vertices are merged.

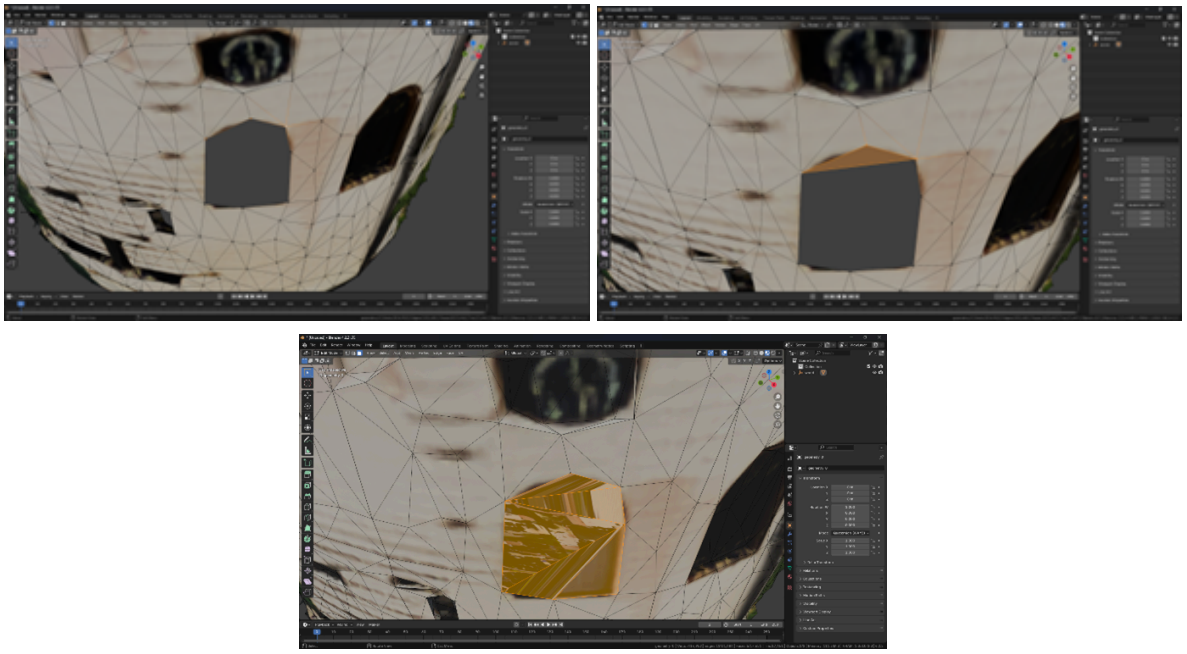


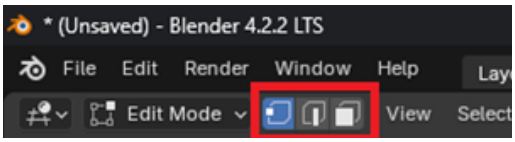
Figure 14 Example of closing gaps in Blender

Important: The texture will appear out of place; this is because the existing texture mapping is based on the mesh generated by Trellis. Once surface reconstructions are performed on the mesh, the reference to the existing mapping is lost. However, this isn't a problem, as the texture will be replaced later and the mapping will be done manually again.

Moving or merging vertices

Deleting a face may also leave vertices without any connection to other vertices. Furthermore, you may want to reduce the number of polygons of the generated model by eliminating excessively small ones and reconstructing them by joining their vertices to others belonging to other polygons. It is therefore necessary to intervene on individual vertices. Vertices are moved as with any other object in the scene, provided you first enter Edit Mode.

1. **Select Vertices filter**



2. **Move vertices**
    a. Select the vertex you want to move
    b. Press the G key on your keyboard to begin the movement
        i. You can constrain the movement along one or more axes after pressing the move key: click the X, Y, Z keys on the keyboard to move the elements along a single Cartesian axis or SHIFT+X, Y, or Z on the keyboard to move the elements on a plane.
3. **Merge vertices**
    a. Select the vertices you want to merge, by holding down SHIFT and clicking on the individual vertices.
    b. Press M (merge) on your keyboard.
    c. A context menu opens
        i. Choice a vertex merging mode

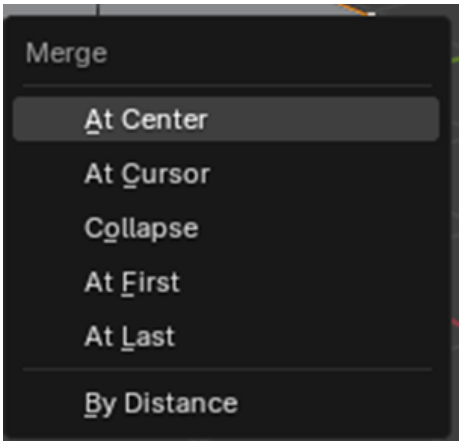


Figure 15 Context menu for merging vertices

Step 4: Texture preparation (Photopea)

During model generation, Trellis is able to create a texture from the photos it receives as input. If only a single photo is provided, Trellis interprets the missing information using the database of photos used for training. When multiple images are provided, the AI tool attempts to interpolate all the information to meet the reliability parameter settings set before generation. Sometimes, however, the texture content is generated arbitrarily, and the resolution is not high enough to be considered optimal in most cases. It is therefore necessary to create a texture manually from locally available images.

The main operations involved in creating the texture are:

- compositing multiple images,
- eliminating unnecessary details,
- straightening to correct perspective aberration,
- balancing brightness and contrast.

📺 **Watch the demo via this link: TEXTURES PREPARATION (PHOTOPEA)**

Import images for texture

1. Open Photopea
2. Import images into Photopea
    a. Select 'Open from computer'
    b. Select the image you want to modify

Tip: Use an image taken as close to the object as possible, so as not to lose details.

Image cleaning

1. Select the area you want to clean
    a. You can use Rectangular selection, Lasso selection (normal, polygonal, magnetic) or Magic Wand selection.
2. Press **DELETE** on your keyboard to delete the selected area
3. To fill in the empty area
    a. Option 1
        i. Right click on the selection
        ii. Choose 'Fill'. It will open a dialog window to select the filling method
        iii. Choose 'Content aware'

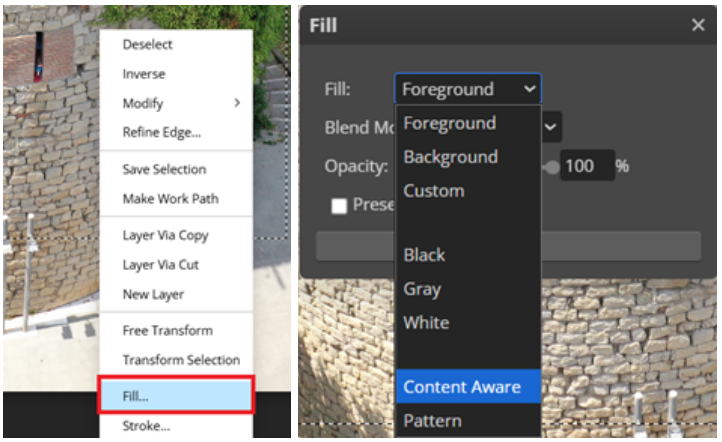


Figure 16 Filling method in Photopea

b. Option 2: the Clone tool

i. Select an existing part of the image you want to copy
ii. Select the Clone tool
iii. Copy the content to the empty area you first cleaned.

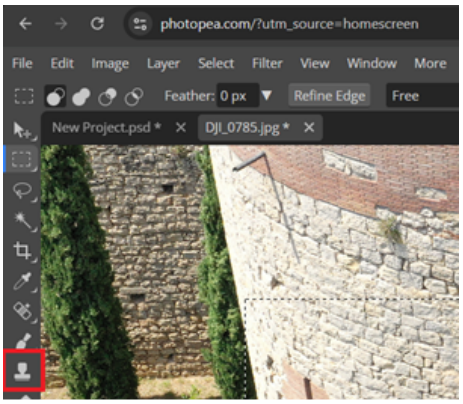


Figure 17 Clone tool in Photopea

Straightening for perspective aberration correction

In some cases, such as when taking a photo of a tower, the image appears distorted due to the curvature of the tower itself. Since it isn't a flat surface, it's not possible to use the photo as a basis for creating a texture. It's therefore necessary to straighten the image to obtain a "flat" image that can be used as a texture. The first step involves isolating a section of the photo where the shooting point is perpendicular to the surface of the tower.

1. Use **the Trim tool**.
2. **Crop the image**.
    a. The crop should result in an image with a 1:1 aspect ratio, preferably.
3. Isolate the section deemed suitable for creating the texture.

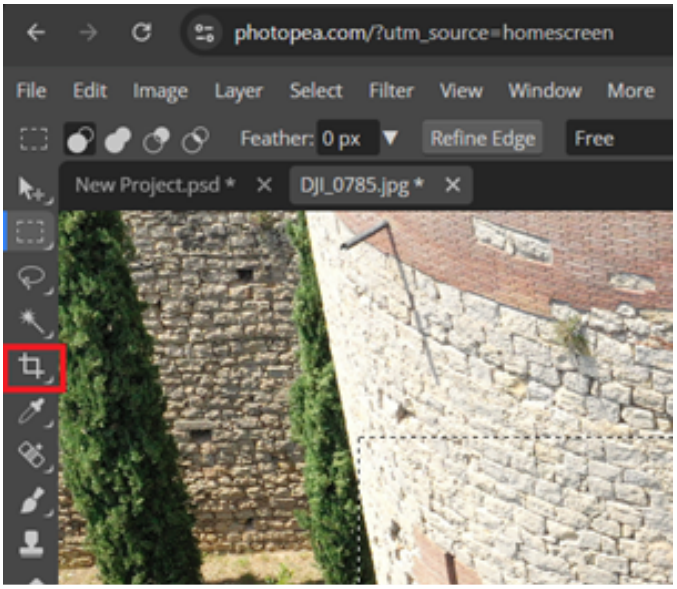


Figure 18 Trim tool in Photopea

Figure 19 Crop for texture with 1:1 ratio in Photopea

4. Now **straighten the photo** to obtain a flat texture
    a. Go to **Edit** → **Transform** → **Warp tool**.
        i. The image will be surrounded by squares and dots on the edges of the image
    b. **Drag the grips** to straighten the image

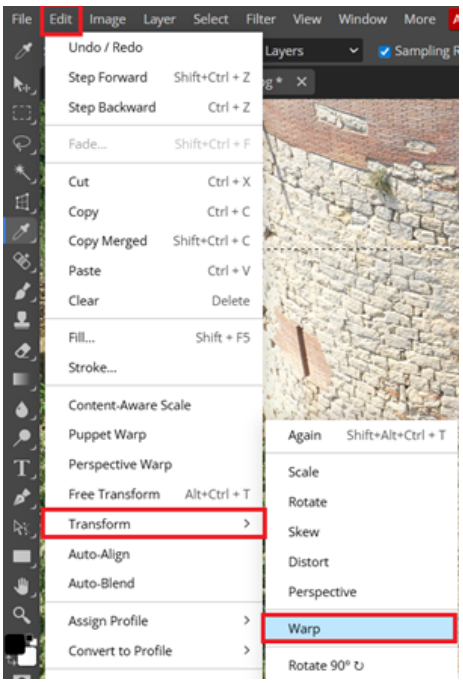


Figure 20 Warp tool in Photopea

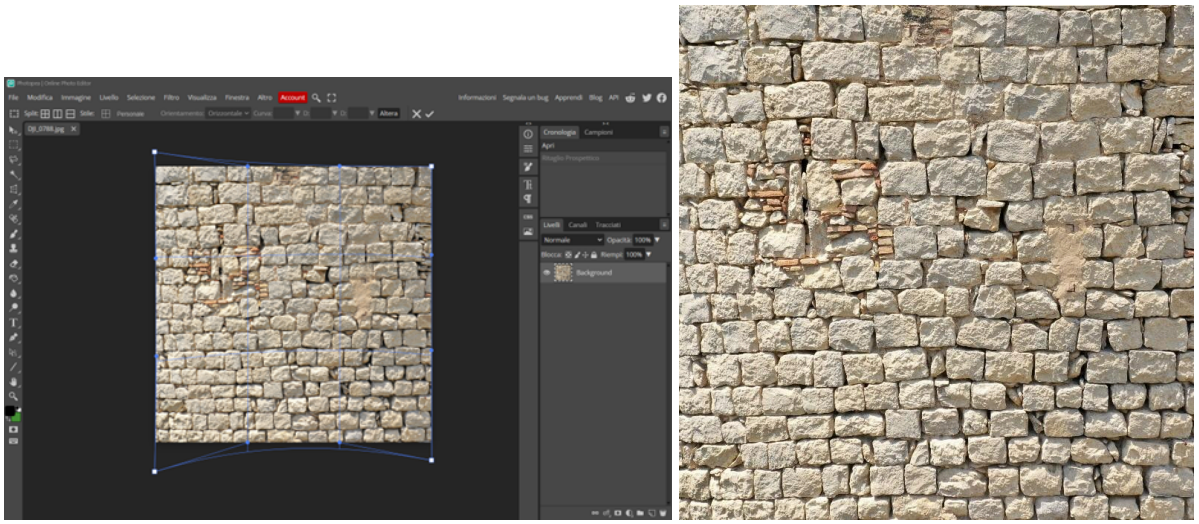


Figure 21 Left: before straightening. Right: result after straightening in Photopea

Brightness and contrast

The image you just obtained, may have lighter or darker areas due to shadows or uneven sunlight. This causes the appearance of cuts, even abrupt ones, when applying the texture to the final object. To prevent this behavior, the texture must be modified to make the brightness and contrast uniform.

1. Go to **Image** → **Adjustments** → **Brightness/Contrast…**
2. **Adjust brightness and contrast**
3. Click '**OK**'

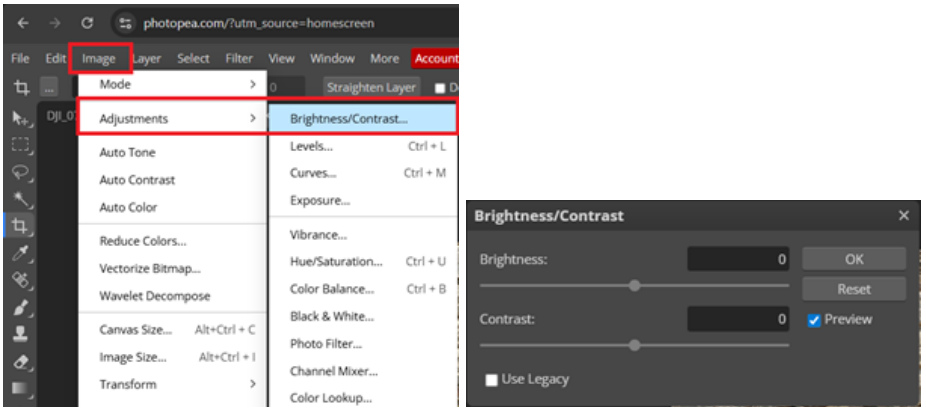


Figure 22 Path to adjust brightness and contrast in Photopea

CREATE SEAMLESS TEXTURES

In the previous step, a texture was created that can be repeated multiple times across the entire surface. However, this repetition can cause visible sharp cuts that break the surface's continuity, making the model unrealistic. **To create a seamless texture from an image, you must first translate it horizontally and vertically to see how repetition can affect the final result.**

1. Go to **Filter** → **Other** → **Offset**…

2. Move the image horizontally and vertically by an amount equal to half the resolution.
    a. To know the image resolution, go to **Image** → **Image Size** and note the resolution.

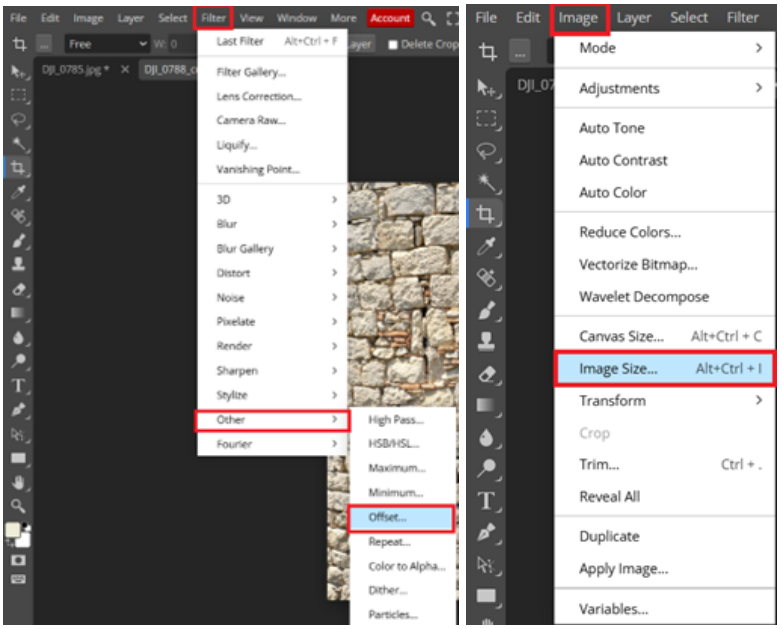


Figure 23 Left: path for offset. Right: path to retrieve image size in Photopea

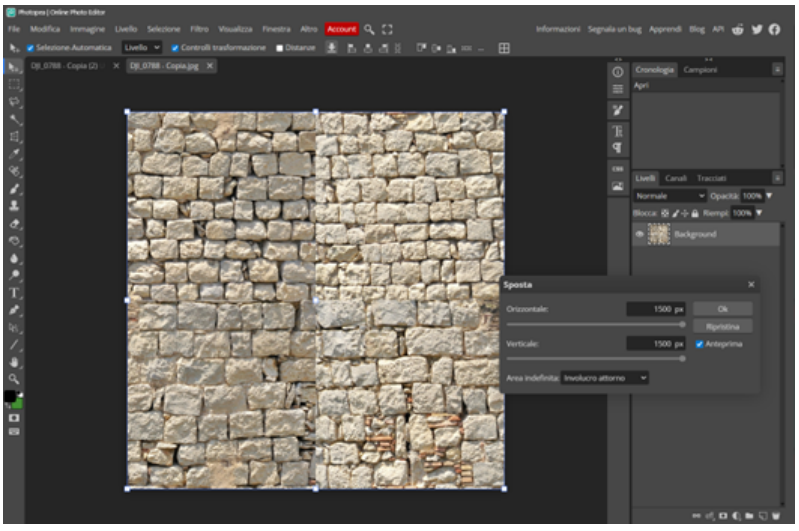


Figure 24 Offset command in Photopea

By performing the **Offset command**, you may notice that the connection between one repetition and the next has discontinuities. Once you confirm the move, **you must then adjust each image in the repeated areas, proceeding as described above in the Image Cleaning section.**

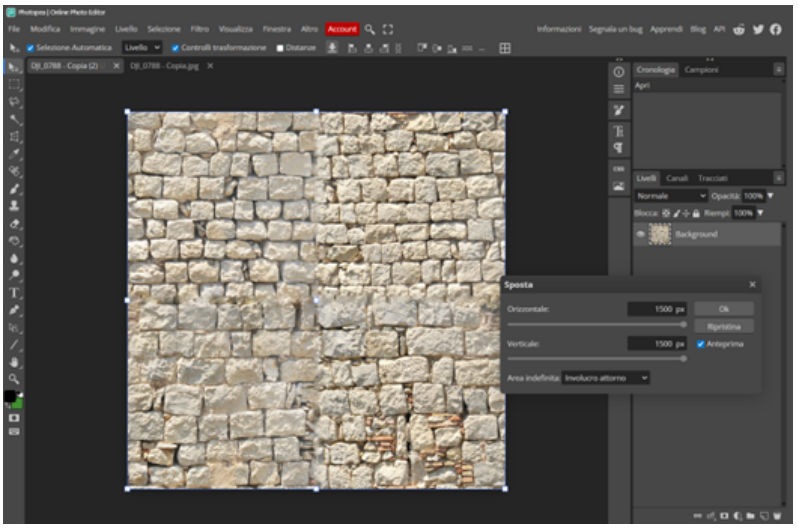


Figure 25 Offset command in Photopea

Once you've fixed the seams between each repetition, you can reset the image's positioning with the **Filter** → **Other** → **Offset command** and move the image horizontally and vertically by an amount equal to half the resolution in negative value. So considering the same image, you need to move it horizontally and vertically by -1500 pixels.

TEXTURE EXPORT

To export the texture, click **File** → **Export As...** → **PNG**

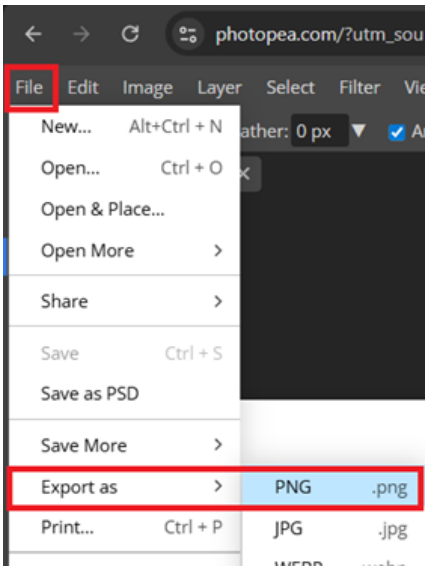


Figure 26 Export path in Photopea

Step 5: Apply the texture to the 3D model (Blender)

The final step involves applying the newly created texture to the model obtained previously after the mesh cleaning operations. The application that allows you to perform this operation is once again Blender. **After opening a new project and deleting the default objects from the scene**, you need to import the model to which you want to apply the texture.

> Watch the demo via this link: APPLYING TEXTURE TO THE 3D MODEL (BLENDER)

Import the 3D model

1. Go to '**File**'
2. Select '**Import**'
3. Select the file type
    a. Models output to Trellis have a .GLB extension, so you need to select **glTF 2.0 (.glb/.gltf)**.
4. Choose the desired file from your browser
5. Select **Import glTF 2.0**.

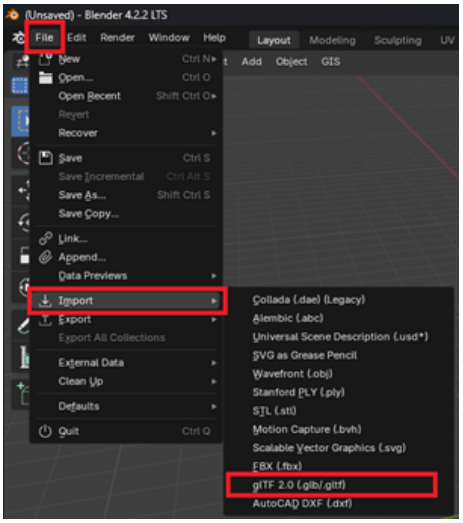


Figure 27 Import path in Blender

Material creation and texture import

1. Select **the Material view mode** in the right sidebar
    a. The model generated by Trellis already has a material with an assigned texture. You can edit the existing material or delete it and create a new one.
2. Expand the **Surface section**
3. Click the arrow next to the Base Color entry
    a. Under Base Color you will see that a texture has already been assigned. This is the one assigned by Trellis during the 3D model generation.
    b. To replace it with the one created with the previous step, **click the cross on the left next to the file name**. The display will now change.
4. Click '**Open**' to open the file browser that allows you to load the texture you created in Photopea.

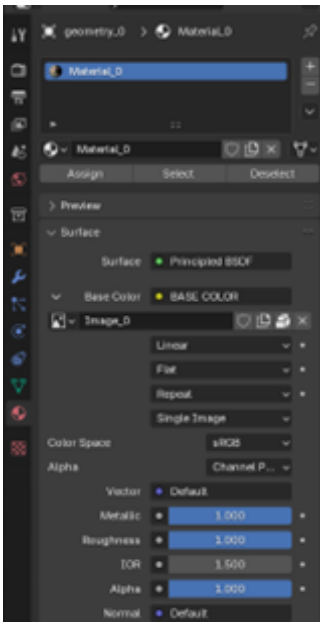


Figure 28 Material view mode in Blender

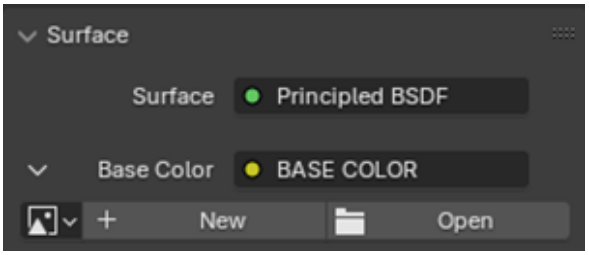


Figure 29 Surface section in Blender

5. Click '**Open image**'.
    a. It is immediately applied to the entire model, but not uniformly, as you can see below.
    b. To solve this problem, you need to perform a correct UV mapping, which is described further in this manual.

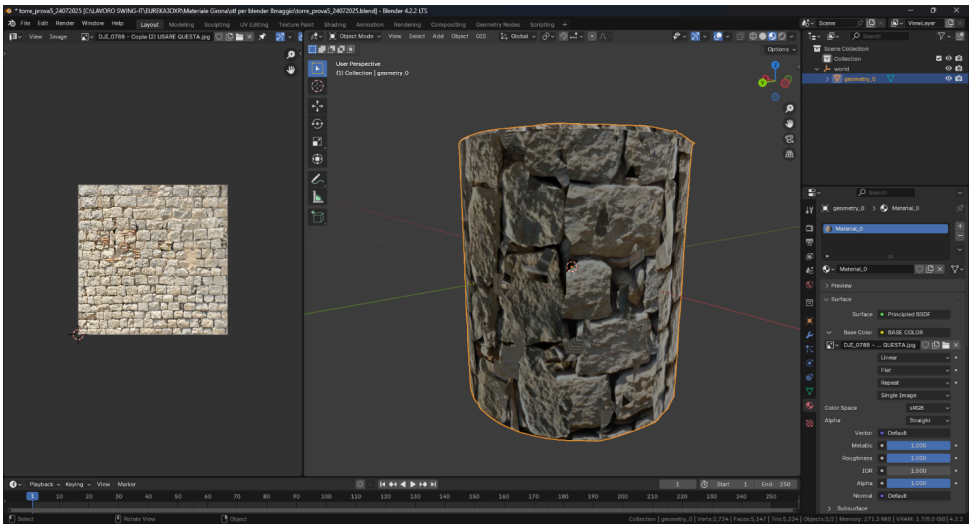


Figure 30 Result after uploading a new texture file

6. If your object must be opaque, set the value of the Metallic parameter to 0 (the default setting is 1).

Applying textured material and correct positioning

Once you have created the material and adjusted its parameters (such as roughness, gloss, or colour), you can apply it either to the entire mesh or to selected parts of the model. By default, a material is assigned to the whole object, but this can be refined depending on your needs.

If you only want the material to affect specific areas:

1. Select the model
2. Go to **Edit Mode**
3. Use the Faces filter to select all faces you want to assign the material

4. In the Material tab: select the desired material and click 'Assign'.

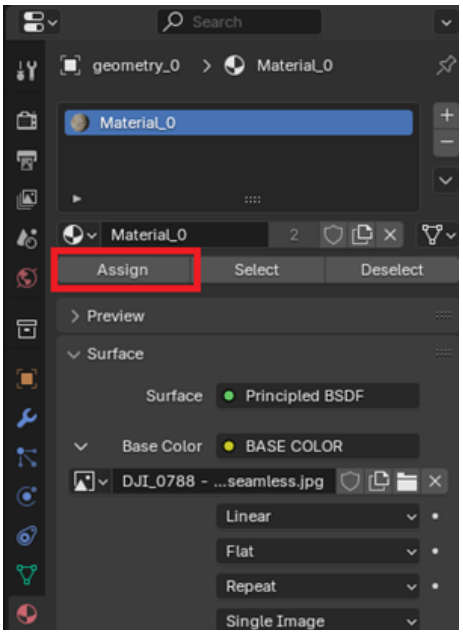


Figure 31 Assign a Material to a face

Note: The texture will be displayed incorrectly, as it needs to be mapped, which is described in the next step.

UV mapping

UV mapping is necessary to tell Blender how to distribute the texture across the model's surfaces. When calculating the model, Trellis can map the texture that is generated concurrently; changing the texture doesn't always mean the same mapping can be used.

Take a look at this example

You may notice that the texture you want to assign fills each polygon randomly. Since this isn't what you're looking for, you need to recalculate the mapping so that the texture is applied to the entire model in an orderly fashion, rather than to individual polygons.

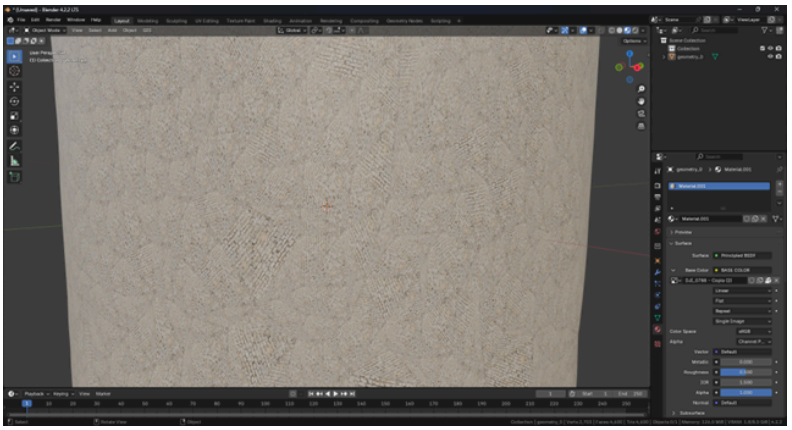


Figure 32 Example of a misaligned texture an a model before UV mapping

For UV Mapping

1. Enter **Edit mode**
2. Set the **Face filter**

3. **Press 'A'** on your keyboard to select all faces
4. Click right to open the context menu
5. Select **'UV Unwrap Faces'** → **'Unwrap'**

This way, the entire surface of the model is wrapped around the texture.

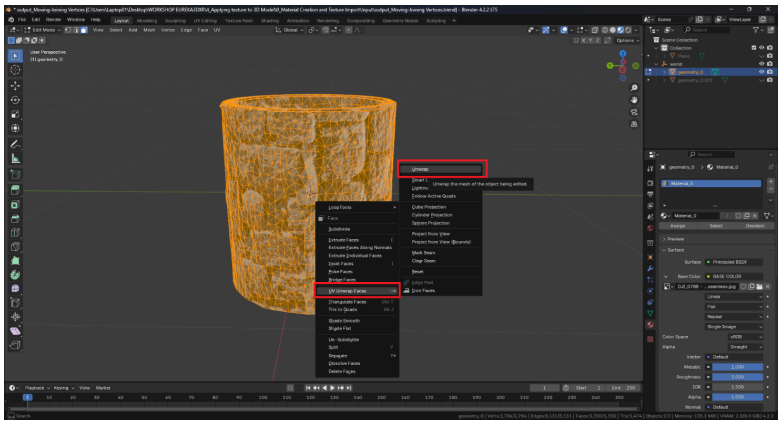


Figure 33 Context menu for unwrapping the model

From this point, you can intervene in two ways:

Option 1: if the object has a complex volume

1. Right click with all faces selected
2. In the context menu select **UV Unwrap Faces** → **Smart UV Project**

It cuts the mesh based on an angle threshold (angular changes in your mesh). This gives you fine control over how automatic seams are created. It is a good method for simple and complex

geometric forms, such as mechanical objects or architecture. This algorithm examines the shape of your object, the faces selected and their relation to one another, and creates a UV map based on this information and settings that you supply.

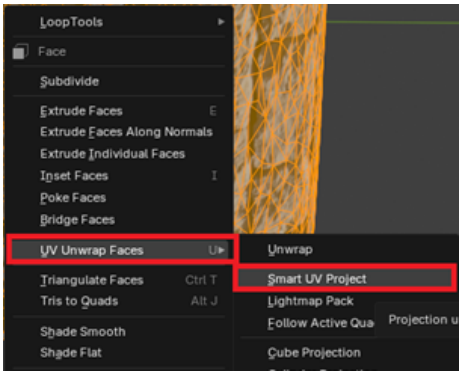


Figure 34 Smart UV Project

Option 2: if the object has a regular shape (cube, cylinder, sphere)

1. Right click with all faces selected
2. In the context menu select **UV Unwrap Faces → Cube/Cylinder/Sphere Projection**
    a. This way, a mapping already adapted to the shape is applied.

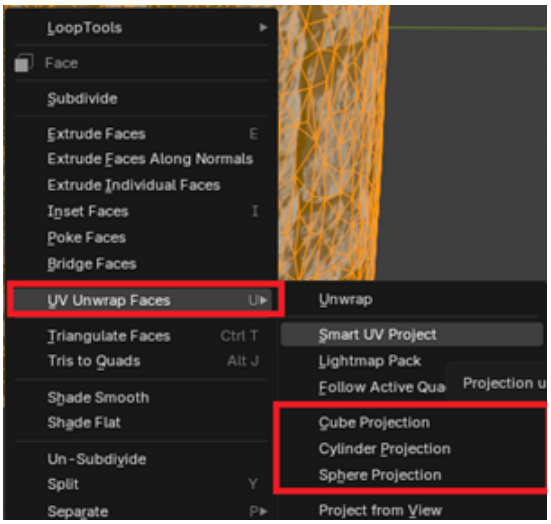


Figure 35 Cube/Cylinder/Sphere Projection

Exporting the final model

The final step is to export the newly created model in a format compatible with the EUreka3D-XR Project tools.

1. Select the 3D model
2. Click **File → Export → glTF 2.0 (.glb/.gltf)**

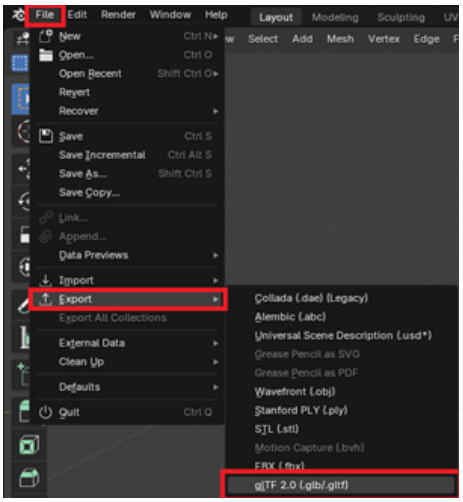


Figure 36 File export path

Important: Inside the file browser it is important to expand the Include section drop-down menu and check the Limit to Selected Objects option, otherwise objects outside of the one of interest could be exported.

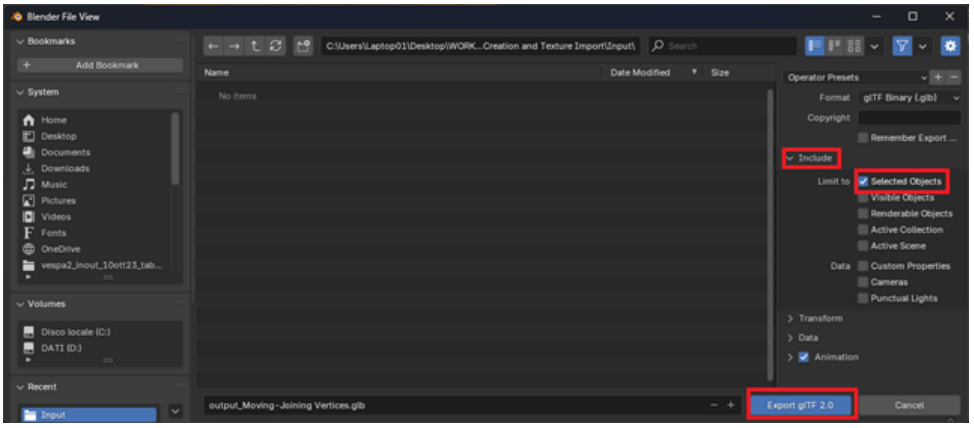


Figure 37 File browser for export